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THE
ART OF IRON MOULDING,

IN

All its Various Branches.

BY

AN EXPERIENCED WORKMAN.

DEDICATED TO THE

MOULDERS OF THE UNITED STATES.



BOSTON:

PUBLISHED BY JOHN PHILBRICK,
46 Hanover Street,

UNDER THE AMERICAN HOUSE.

1853.

TS 230
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Entered according to act of Congress in the year 1853,
By EDWARD CAREY,
In the Clerk's Office of the District Court of Massachusetts.

8-9480

J. M. Hewes & Co., Printers....81 Cornhill, Boston.

INTRODUCTION.

THE object of writing this work is to give the moulder a general knowledge of his business, with a little practical experience. The necessity of a work of this kind has been very seriously felt. To men who do not understand heavy work, it will be found convenient for frequent reference. Persons who have a copy of the work should keep it by them in their working hours. It will serve to remove doubts from the mind of the moulder, whilst moulding and pouring his work. Apprentices, and workmen of little experience, will find it a very instructive volume, enabling them to go through their business with much more ease and com-

fort than they do at present. Green Sand moulders can gain from the work an idea of the manner in which Loam and Dry Sand work is done, and the Dry Sand moulder can also learn an idea in relation to Green Sand work.

The writer asks and expects no more or other compensation for his labor than a just and generous patronage.

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ART OF MOULDING,

IN

ALL ITS BRANCHES.



THE branch of Iron Moulding, to which we shall first turn our attention, is called heavy work, and consists in moulding large patterns, of every description. A man, well acquainted with this branch of the business, need seldom be in want of employment, as it is a branch with which many workmen are unacquainted. The first part of this branch is gearing of various sizes, and consists of Bevel, Mitre and Spur gearing.

SPUR GEARING. If the pattern be large, the most expeditious method is to turn it over with a crane; if small, it may be done

by hand. If the pattern have strength ribs in the centre, it will be necessary to use lifting plates with feather edges, and three steady pins in each plate. The handles of the plates should not project higher than the top face of the pattern. It is necessary to ram up iron rods in the centre. Before drawing the pattern, vent the centre of the cores and teeth, and carry the vent to the edge of the flask. Before lifting out your cores, each should be marked with numbers corresponding with the knoll opposite. This is not necessary in plain arm patterns, unless when you vent the teeth. Some moulders ram up iron rods in the teeth of coarse gear patterns, and it is a judicious practice. The best position to place them is horizontal. In order to prevent scabbing, it is necessary there should be a hole through the centre core to convey the iron to the lower part. Four gates filed out of the lower part of the core will be sufficient to run a casting.

To prevent straining, it is necessary to have one Riser opposite each arm near the teeth, as the teeth will strain before any other part. Coarse gearing need not be poured with very sharp iron, but fine gearing requires it. When you commence pouring, pitch lightly. At all times, the Risers should be covered with clay, in order to exclude the air, until the mould is filled. If the Risers are left uncovered while pouring, it will very much injure the mould, particularly if made of facing sand, as the sea coal or coal dust will separate from the moulding sand, and make the casting rough and unsightly.

To Mix Facing Sand. One measure of sea coal to three of sand. *For Coarse Gearing.* One measure of sea coal to four of sand.

MITRE AND BEVEL GEARING. If the flask be too heavy, you should turn the pattern over with a crane. When bedding the pat-

tern, sink it as low in the cope as will make your parting square with the edge of the knoll. When making the parting, put some damp beach sand on the teeth, as by so doing, you will obtain a good lift with your cope. Patterns that have loose arms will not need lifting plates, as the arms can be lifted in the cope before you draw the arms. Spike it well to prevent it from falling. If the pattern have not loose arms, it will be necessary to use lifting plates, the handles of which must not project higher than the arms of the patterns. To strengthen the cores, it will be necessary to ram iron rods in them; and to keep them from cracking, to vent the cores and teeth, in the same way as the spur gear pattern. The teeth of bevel and mitre patterns are more apt to scale while pouring, than the spur, as they are more exposed. The iron comes on to the teeth as soon as it is poured. To prevent this, have a gate or sprew in your centre core, and file four gates in the lower part

of the core. When you put in your centre core, the gates should be opposite the arms. The teeth of these patterns should be rammed with care.

To prevent swelling and straining, it is necessary to put a Riser on each arm near the teeth. As soon as the mould is full, stop pouring for a while, until the casting is set, after which, pour some iron in the hub to prevent it from shrinking. The Risers must be kept covered while pouring, in order to prevent the mould from drawing air.

BEDDING MITRE AND BEVEL GEARING PATTERNS. There are various modes of bedding these patterns, the most expeditious and best of which is the following :

The arms should first be bedded. The arms and teeth should not be bedded at the same time, for when you lift your pattern, you will want to rub the teeth with waste. The arms should be marked before lifting

the pattern. Sprinkle water over the teeth with a soft brush. Sift a little facing sand over the teeth, and when you have them rammed, turn over the pattern, and lay it in the same way you took it out; then ram sand outside the teeth, to prevent them from falling while rapping down the pattern. Sink your lifting plates to the lower edge of the arms, and when you have them fitted, lift them out and clay wash them. The cores should be first rammed up, before you make a parting on the teeth. When you have made your parting, you should put on your cope; divide it at an equal distance from the pattern, and rap it down with a heavy hammer until completely even. Drive wooden stakes, standing as upright as possible. After this, lift off your cope, put on parting sand, and clay wash the cope. This mould should be vented, in the same way as the former.

When you have finished your mould, weigh down your cope. It will be neces-

sary to weigh four tons of iron for every one the casting will weigh. This will prevent the iron from running out while pouring.

There is more *strain* on bevel and mitre gearing than on spur.

The most expeditious way to mould small bevel gearing is to ram the cope, and sink the pattern as low in the cope as will make the parting even with the edge of your knoll. Ram your cores well, after which put in your lifting plates before you sift sand on your pattern. When you turn your pattern over, you need not take the sand out of the arms, as the cores of small patterns will not need iron rods. Lift out your cores with a close tongs, and place them on a level board, or bed of moulding sand. If you have no lifting plates, and cannot wait until they are made, there is still another mode of moulding these patterns, not yet generally known in New England.

Bed your pattern on your cope, and ram

your cores for the time. Slick the sand even with the top of the arms, put on parting sand in the centre, and sift on your facing sand over the pattern. When you make your parting ram, your cores and the centre of your cope should be harder than usual. When drawing your pattern, you may either leave the sand in the arms, or not, as most convenient, before swabbing your pattern. Before drawing it, mark one of the arms with chalk, and also the same arm in the cope. When drawn, fit the pattern on the cope, and make your cores in the cope. When ramming your cores, spike well. Vent the cope before drawing your pattern. This mode is not so expeditious as with lifting plates, but it is as good as any other.

When you put on your cope, the cores will touch in the knoll as if laid in with lifting plates. Wooden lifting plates are used, instead of iron ones, in some parts of the country, but iron plates are the best and

cheapest. Wooden plates will spring, and crack the cores.

The best way to pour small bevel and mitre gear is to fit four gates in the top of the centre core. The gates should be opposite the arms. This will prevent the cores from first striking the cores. It will be necessary to have risers near the teeth to prevent it from straining while pouring, as is done with large castings. Gearing can be made from common moulding sand, but is more apt to scale than when made in facing sand, and the castings will not have so smooth a surface.

One measure of sea coal to five of sand, or one of sea coal to six of sand, will be sufficient for five patterns.

SPUR SEGMENTS. The best way to mould this pattern is to turn it over. If there is not a flask deep enough, bed it in the floor. When you ram the teeth, it will be necessary to put iron rods in them. The best

way to run segments is to have the gates as near the bottom as possible; the castings will not be so apt to strain as if run at the top. The iron need not be poured very sharp, as it would make the casting rough. The teeth should be vented, and the vents conveyed to the joint of the cope. The risers must be kept covered with clay while pouring. It will be necessary to have a riser on each end, and one in the centre. If the casting is heavy, it will be necessary to churn the risers with an iron rod until it will set. When the risers are setting, care must be taken to pour in sharp iron before the iron sinks too low.

The facing sand for segments should be mixed in the same proportion as given in the former Recipes.

PLANER BEDS. Bed the ways or slides in the knoll, and the lifting plates at the same time, but first ram the cores. There is no need of making a parting on the cores until

the cheeks are rammed, as this will save the labor of turning over the knoll before you draw the pattern. It is necessary to vent the cheeks and centre cores. Ram up sprews in the cope for the vent; in order to get off the cores when the pattern is drawn, dress the cheeks. After lifting them off, stay the centre of the cheeks before they are lifted off. The cores should be placed on a level bed of sand or board. Put in the cores, when the ways are drawn, before the cheeks are put on.

The best mode of running planers is to do it in the ways or slides, which will keep them from scabbing. Whilst pouring, the riser should be kept covered with clay, and a double shanked ladle used to pour at one end. Pour as soon as the ways are covered with iron, having a ladle at both ends. There is no need of pouring much out of the large ladle, unless the mould is thin, when it will be necessary to do so.

LATHE BEDS. Turn the ways over in the knoll, and vent the pattern before you turn it over. If the ways are rammed too hard, it will scale; if too soft, it will swell. The cheeks can be rammed hard, if well vented.

The best mode of ramming lathe beds is in the ways. If the casting is to be heavy, two crane ladles will be necessary for pouring. Commence at first with one, until the bottom of the ways is covered. If the two ladles should be used at first, the ways will be apt to strain. If the centre cores are made of green sand, lifting plates will be needed; if of dry, the plates can be rammed in the dry sand core. The cheeks should be lifted off before the cores are taken out. The risers should be kept covered with clay whilst pouring beds with hollow sides and core. The cheeks must be lifted off sideways, and a centre core made in a core box of green or dry sand.

BEDS FOR HORIZONTAL STEAM ENGINES.

Turn the pattern over with a crane, if the

knoll is too heavy to turn by hand. Facing sand is the best in which to mould this pattern, as it is not so apt to scab if well vented, as common moulding sand. The facing sand for the grooves should be a little damper than will be sifted on the pattern. There will be no need of slides, if the top side is plain and has a good cope; but if there are two, three or four inches of sand to lift in the cope, slides on the knoll and cross pieces of the cope should be fitted to the pattern. Iron lifters are the best to use in the cope, as the sand is apt to peel from wooden ones while pouring.

The best way to run beds is in the lower part of the flange, and with two crane ladles. To run square, the iron must be sharp and poured with a good stream. To prevent it from being feign run, eight risers, at least, will be wanted; to prevent it from straining, the risers should be covered while pouring.

COLUMNS. Turn over the pattern. It is better to have it in two halves; if it is whole, the speediest mode is to bed it. The bottom and sides should be rammed hard to prevent them from straining. Care must be taken not to ram hard on the pattern, for hard ramming will blister and shell the top of the casting. The risers will need to be churned for patterns with square collars. A riser will be needed on both ends of columns.

The best mode of running heavy castings, is to gate them on the side. Small ones can be run on the top. If there is to be a good thickness of iron in the casting, it will be best not to pour it with sharp iron; if thin, sharp iron will be the safest. Iron not too dull will be fittest for pouring in heavy casting, as it will not penetrate through the sand so much as sharp iron will, and besides, it gives the casting a smoother surface, if the facing sand is strong enough. When pouring, pitch lightly and pour rap-

idly, when you commence. The risers must be kept covered, and the centre core vented at both ends. In some shops, it is customary not to vent the core until after the pouring is completed, but this is a bad practice.

PATENT WATER WHEEL. Place the pattern on a mould board, and ram the cheeks. Place iron rods in the cores between the buckets. Have a sprew as near the centre as possible. The pattern should be all in the cheeks, as it will give plain copes. Before the pattern is drawn, the bucket cores should be vented; when the run is drawn, swab the bucket pieces, and loosen them a little, before you turn over the knoll and cheeks, and also gate it. The sprew in the centre should not be drawn until the mould is finished in the bottom. The flange is the best place to run it, in order to prevent it from straining or scabbing. When pouring, pitch lightly until the bottom is covered;

then pour rapidly until the mould is nearly full. Put on as many risers as will prevent it from straining. The larger the number of risers are put on a casting, the less it will strain. They should always be kept covered while pouring. Facing sand draws more air than common moulding sand, on account of the sea coal.

FLY WHEEL, WITH CAST AND WROUGHT IRON ARMS. If the knoll is too heavy to turn by hand, turn over the pattern with a crane. If the casting is all to be cast iron, it will be necessary to cool the rim and keep the arms and centre covered until the casting has done shrinking. If there is a core in the centre, dig it out as soon as the casting will set. If the rim be heavy there should be risers to prevent it from shrinking. The rim should be poured with dull iron; the arms and centre with sharp. If the casting be of wrought iron arms, the rim should be first poured, and

afterwards the hule. If the hule is left unpoured too long, or until after the rim has commenced shrinking, it will drive the arms back into the hule, and force the sand into the mould. If there be no flask in which to mould this pattern, it can be bedded in the floor. Ram it the same as if turned over. Facing sand is the best in which to bed fly wheels with, in order to keep them from scabbing.

HEAVY PULLEYS. If the knoll be heavy, turn it over with a crane. The knoll part of the pattern must be rammed harder than the cope. Care must be taken not to ram the cope too hard. When it is lifted off, turn it over, if possible, before the part in the cope is drawn. In order to prevent it from falling while turning over, it should be well spiked. If it cannot be turned, it should be well gagged, while the cope is ramming, to prevent the sand from falling, while it is drawing out of the cope. Care

must be taken not to draw it too rapidly. Flat risers on top of the rim are best to prevent straining. Sharp iron is best for pulleys of large circumference. You should not pour very rapidly until the iron is as high as the joint of the flask.

A pulley is more apt to strain in the knoll part, than in the cope. The best place to run pulleys is in the arms and rim.

BOILER HEADS. Turn over the pattern. The centre, particularly the hips, should not be rammed very hard, because on them the iron first strikes. If the pattern has a branch pipe on the top, first ram the branch. When the cope is rammed, make a parting on the branch, and fit a cope that will rest on the top of the cross pieces. Draw the branch before the cope is lifted off. The knoll and cope must be well vented. The vent on the knoll must be taken off as soon as the moulder commences pouring. This will prevent it from scabbing if rammed with skill and care.

The usual way to run boiler heads is on the side, and it is the best way to prevent it from straining. Before the cope is put on, cut the sand behind the gate, which will prevent the iron from running out. Heads need not be poured with sharp iron. Plain patterns will require the same usage as the above mentioned.

HEAVY AND LIGHT WATER PIPES. The knoll and the sides of the cope must be rammed hard. The top should not be rammed very hard, else the casting will be apt to shell and blister. If the pattern is of one piece, it will save the moulder much unnecessary labor to turn the cope over before it is lifted off the pattern. In order to obtain a good lift, the pattern should be rapped at both ends. The sides are the best places to run pipe. Dry sand cores will make sounder castings than green. Pipe flasks should have cast iron ends for the arbor to rest upon, in order to prevent the core

from yielding in the knoll. If the ends of the cope do not fit tightly on the arbor, it will be necessary to place an iron wedge between them, in order to prevent the core from rising while the casting is pouring. The iron should be sharp. One riser on each end will be needed. Pipe should be poured rapidly in order to make castings.

GREEN SAND WATER WHEEL SHAFTS. The pattern should be moulded in two halves. The knoll part should be rammed harder than the cope, for the reason that the pressure of the iron first comes upon it. The cope should be well spiked before the pattern is drawn. To prevent it from falling while turning over, chaplets should be placed in the bottom, side and top. The weights should not touch within half an inch of the chaplet tops. Small iron wedges are best with which to fasten the chaplets; this will give the casting an equal thickness, and the casting will be stronger

than if poured solid. The best place in which to run shafts is the side. A sturge sprew will be necessary for it to flow into while the casting is pouring. The most useful part of a shaft on which to put risers is the journals, as they are to be finished in a lathe. The risers must be churned until the casting is set. If the pattern is to be bedded in the floor, it will require the same usage as is mentioned above.

WATER WHEEL SHROUDING. Turn it over on a smooth board, if the pattern be plain on the back; if not, the cope must be rammed temporarily and turned over upon it. The sides and ends can be rammed hard. Facing sand is the best to prevent shrouding from scabbing. The knoll and cope should be well vented. Sharp iron will be the best, with light gates, and as many risers as will prevent it from straining. It need not be poured very rapidly, if the iron be sharp; otherwise it may require it. The

risers, of course, should be kept covered while pouring, and the vent taken from the knoll and cope also.

WATER WHEEL SHAFT CENTRES. If the pattern be in two halves, turn it over on a mould board; if not, the cope must be rammed temporarily, and the pattern turned upon it. The edges must be rammed hard, but not the centre. If the pattern be in halves, the cope must be spiked before it is drawn, to prevent it from falling whilst turning over. Facing sand is best to prevent it from scabbing. The knoll and cope should be well vented. The best place to run it is in the side, but if the pattern is feather-edged, it must be run through the centre core as gearing. Care must be taken not to pour it with sharp iron. Pour rapidly and pitch light.

TAIL STOCKS FOR LARGE CHUCK LATHES. Turn over the pattern on the cope. To prevent scabbing, facing sand should be

used on the top and bottom face. The knoll and cope should be well vented before it is turned over. The lower part of the flange is the best place to run this pattern. The iron will fill more even, and will not strain so much as when poured at the top. To make a sound casting, a light pitch and rapid pouring will be best. Take off the vent from the bottom and top whilst pouring.

HEAD STOCKS. Bed them in the floor. The knoll part will require hard ramming to prevent swelling. The feet should be rammed with facing sand, to prevent them from cutting up when pouring. The feet is the best place in which to run the mould. Care must be taken not to gate it on the cores. It need not be poured with sharp iron; the casting will be smoother if it is done with dull. Give a light pitch and pour rapidly, and have risers at both ends.

CHUCK PLATES FOR LARGE LATHES. Turn over the pattern on a mould board. The top ribs should be loose to come up in the cope before the ribs are drawn. The sand should be spiked well to prevent it from falling. While turning over, the knoll and cope should be well vented, and poured in the side to prevent scabbing. There should be a large riser on the hub, and as many in other parts of the casting as will prevent straining. Care must be taken that the slot cores be not too long; if they are, the cope will fall to pieces. A calloper is the best guide to go by. When the cores are set, put on the cope to ascertain if they touch. Frequently some of the cores are too long, and it is therefore necessary to lift it off and try. This will remove all doubt from the mind of the moulder, and is much the safer way. Facing sand is the best to prevent scabbing, but common moulding sand is the best to make a good casting, if well rammed.

TABLES FOR PLAINER BEDS. Turn over the pattern on a mould board with a crane, if it cannot be done by hand. The sides and ends should be rammed hard; the pattern must not be rammed with the peen. Facing sand is the best to use for the bottom parts, and common moulding sand for the cope. The cope and knoll should be well vented, in order to prevent scabbing and air holes made on the top. To prevent it from falling while turning over, the slides should be spiked before they are drawn out of the cope. Risers should be placed in the slides; the sturge will flow through and make them sound. Tables should be poured at both ends with sturge sprews; the gates should be deep and narrow to prevent the sturge from going in. Sharp iron is preferable to make sound top slides, and should be poured rapidly. When the slot cores are set, try on the cope, and lift it off again to ascertain if it touches correctly.

If tables are poured with dull iron, the top slides will resemble a honey-comb.

ENTABLATURES FOR UPRIGHT STEAM ENGINES. Turn over the pattern with a crane; if it be in halves turn it over on a mould board. The sides must be rammed hard; the bottom and top face of the pattern can be rammed hard with a butt rammer. Facing sand is the best to mould it in. It must be well vented before the part in the cope is drawn. It should be well spiked to prevent it from falling while turning over. The best place to run it is at both ends. Dull iron is the best to make the casting smooth. Pour rapidly to prevent it from being cold shot. Keep the risers well covered while pouring, with clay.

SWING BEAMS FOR UPRIGHT STEAM ENGINES. Turn the pattern over on a mould board. It will be better to have the top ribs and hubs on loose than fast. The face

of the pattern should not be rammed very hard, but the sides and ends should be, in order to prevent it from straining. The best place to run them is at the ends; the hubs the best place on which to put risers. The mould must be well vented when pouring. Pitch lightly: the iron need not be very sharp, nor need it be poured rapidly until the bottom is covered.

CONNECTING RODS FOR UPRIGHT STEAM ENGINES. The easiest way to mould this pattern is in halves. Turn it over on a mould board by hand, if not too heavy. If not in halves, it must be turned over on the cope. Facing sand is the best to prevent it from scabbing. The cope and knoll should be vented. If one half the pattern is in the cope, it will be necessary to spike the sand before the pattern is drawn out, to prevent it from falling while turning over. If there is room enough, the side will be the best place to run it; if not, it must be poured in

the ends. The iron need not be very sharp. Pitch lightly and pour rapidly, until the mould is nearly full ; then bring it up lightly. This will prevent the casting from straining, if the wood is well rammed, and risers in the centre.

CRANKS FOR UPRIGHT STEAM ENGINES. Turn the pattern on a smooth board. The sides will need hard ramming. Facing sand is the best to prevent it from scabbing. The best place to run it is in the bottom of the hub. Pour with dull iron to prevent it from shrinking. The risers should be churned until the casting is set. It need not be poured rapidly.

FIRE PROOF BEAMS. Turn them over on a mould board. If there be no board it must be turned on the cope. Facing sand is the best to prevent scabbing. Vent it well, and do not ram hard over the face with the peen. If there is not room at the ends, run it in

the sides, and place the gates as near the bottom of the sides as possible. When beams are poured in the sides, the pouring should be quite rapid. If the mould is long, it will be necessary to have a shank ladle at both ends. The bottom of the knoll should be vented, while pouring, to let the air off well; it will prevent scabbing. Pour them with sharp iron.

SCREW BACKS. Turn them over on a smooth board. If there is no flask to turn it over, it can be bedded in the floor. The bottom flange should be rammed hard, to prevent swelling. Facing sand is the best to prevent scabbing. The best place to run it is at both ends and the centre, and poured rapid with sharp iron.

Note. Grate bars should be vented in the centre cores and cope also. Pour them at both ends and not very rapidly.

GREEN SAND BED PLATES FOR STEAM BOAT ENGINES. Bed the pattern in the floor.

Facing sand will best prevent scabbing. The sides and ends should be rammed hard, and the bottom with great care. The cope and knoll will need to be well vented, and the bottom vent conveyed outside the joint of the cope. Bed plates should be poured at both ends to prevent straining: it will be necessary to stop pouring when the iron comes into the risers, if the casting is not very thick. Sharp iron and rapid pouring is best. A light pitch with gates in the bottom, and both ladles pouring together, will make a smooth casting.

LOCOMOTIVE WORK.

DRIVER WHEELS. Turn the pattern over on a board. The sides and the arms need to be rammed well with the peen to prevent straining. There is no need of venting the knoll until the cope is lifted off; it should then be vented between the arms. The best place to run it is in the centre. If the bot-

tom part be too hard, the sand will cut up when the iron is poured in. If any of the arms are solid, it will need a thick riser to prevent shrinking. A light pitch is best, and rapid pouring until the mould is nearly full. The iron need not be very sharp; it should be vented on the top, and the risers kept covered whilst pouring, as usual.

CROSS HEADS FOR LOCOMOTIVES. This pattern should be in halves. Turn it on a smooth board. Common moulding sand is the best. Before the part in the cope is drawn, it must be spiked well to prevent it from falling while turning over. If you would have a sound casting, a sturge sprew should be set for it to flow into. Narrow, deep gates will be best to run it, and on the centre of the casting is the best place to put the riser. The cope will need to be well vented. Sharp iron is best for heads. Churn the riser until the casting is set, and keep it covered, of course, while pouring.

PLAIN CYLINDER HEADS. Turn the pattern over on a smooth board. Common moulding sand is the best for this work. Neither the cope or knoll should be rammed hard, except the edges. Care must be taken to vent both well. The best place to ram heads is in the side. A sturge sprew will be necessary. Sharp iron is the best to make sound castings.

TAWS. This pattern should be moulded in halves. The sides and ends can be rammed hard, but not over the pattern. The knoll and cope should be vented before the part in the cope is drawn. The sand will need to be well spiked to prevent it from falling while turning over. The best place to run them is in the side. The iron need not be very sharp nor poured rapidly. A large riser should be placed on the centre of the casting to prevent it from shrinking.

MAN HOLE TOPS. First turn over the round part of the pattern; the oval part is to be rammed in the cheeks. Iron rods should be in it to strengthen the sand. Facing sand will be best to mould them in. The knoll, cope and cheeks must be well vented, to prevent the casting from scabbing. The best place to run it will be in the knoll. The mould should be poured rapidly and with two ladles, with sharp iron.

STEAM CHESTS. This pattern should be moulded in halves. Turn it over on a mould board. Common sand is the best. The sides can be rammed hard, but not on the pattern. The core is to rest on chaplets, and the vent taken off at the round end. Care must be taken to vent it well. Pour with sharp iron; and small gates with a sturge sprew. It will be necessary to run the cold iron of the top; the risers to be kept covered while pouring.

TAWS FOR LOCOMOTIVE TENDERS. First turn over the face side. Put iron rods in the pockets, while the cheeks are ramming. When the cope is lifted off, the vent should be taken from them. Before the cheeks are lifted off, the pattern must be rapped and left in until the part in the knoll is drawn; then put in the cheeks and draw it out. The best place to run it is in the knoll part. All parts of this mould may be rammed hard, except the pockets and the knoll. Sharp iron will be the best, and the pouring should be rapid.

CYLINDER HEADS FOR LOCOMOTIVES. Turn the pattern over on a smooth board, and make a parting in the nozzle. The thickness of sand will need to be secured with spikes. When the nozzle is drawn, put a beake over it, with a hole in the centre for the core to rest in. The knoll and cope must be well vented. Care must be taken not to ram hard over the pattern. Facing

sand will be best for the knoll, and common sand for the cope. The best place to gate it is the side, and set a sturge sprew and a riser on the centre.

CHILL WHEELS. Turn the cope and knoll over. Facing sand will be the best to prevent scabbing. If the casting is to be hollow, chaplets must be set in the knoll and cope, to prevent the core from rising. It will be necessary to have four sprews on the hub to run chills, and to pour rapidly. The chill should be oiled before the pattern is put in. Wheels with arms will need to be lifted in the cope, and to be well spiked before drawn, in order to prevent falling while turning over. Care must be taken not to pour the iron sharp nor very dull; if too dull, the casting will not chill well nor have a smooth surface. Castings should be taken out of the chills as soon as possible, before they heat too much; this will prevent them from bursting. Wheels with wrought

iron arms must be poured in the sides, with two ladles; the hub is to be poured after the chill.

DRY SAND WORK.

DRY SAND MILL SHAFTS. This pattern should be in halves. Turn it on a smooth board. Fire sand and moulding sand are best to prevent scabbing. When the mould is dressed, use blacking wet with strong beer. It is considered best to make heavy work peel. Care must be taken to have the mould dry, and let the steam out of it before it is closed. The best place to run shafts is the bottom; there will not be so much strain as when poured at the top. The iron need not be sharp nor poured rapidly. To prevent it from straining, the mould should be rammed up in a pit, and the riser churned until it will set.

SMALL SHAETS of every description should be cast upright, that is intended to be fin-

ished in a lathe, and churned until the riser is set. It will be best to run them at the bottom; the sturge will flow to the top and make the casting sound.

STEAM CYLINDERS FOR LOCOMOTIVES.

Turn over the pattern on a mould board. The knoll and cope must be rammed hard and well vented before the pattern in the cope is drawn. The sand will need to be well spiked to prevent it from falling while turning over. To prevent it from scabbing, it will be necessary to use fire and moulding sand mixed in equal proportions. When the mould is dressed, black it with blacking wet with strong beer, and smooth it with a half round and other tools. When finished, put it into the oven over night. The valve cores should be vented, and the centre cores made of loam. Before the mould is closed, let all the steam go out of it; the vent must be taken from the valve cores on the side, and nails put in to support them. Cylin-

ders should be poured in the bottom flange with sharp iron, and poured rapidly. The centre core must be secured before the mould is turned on end, to prevent it from falling down. Run at least fifty pounds off the casting; this will make the top flange sound.

DRY SAND WATER PIPE. This pattern should be moulded in halves; turn it over on a mould board. An equal quantity of moulding and fire sand will be best to prevent scabbing. Blacking for pipe should be mixed with strong beer; this will make the sand peel off easily. The best place to run it is on the top with gates all around it, and faucet end downwards. To prevent straining, it should be rammed up in a pit. Sharp iron is the best with which to run upright pipe, as the sturge will flow to the top and make the casting sound, if poured properly and carefully.

SMALL PIPE that are to be cast upright, should be moulded the same way as the above.

DRY SAND CALLENDER ROLLERS. Mould this pattern in halves and turn it on a mould board. To prevent scabbing, use half fire and half moulding sand, and see that it be well vented; centre core in loam. When the mould is dressed, black it with blacking wet with strong beer; the sand will peel off the casting better than if mixed with water. The best place to run rollers is the bottom of the mould; the sturge will flow to the top and make the casting sound. There is no need of pouring very rapidly if the casting is thick.

SMALL ROLLERS of every description should be cast upright, if intended to be finished in a lathe. The mould should not be closed until the steam is out of it. The best place to run small rollers is the bot-

tom part of the mould. Both large and small rollers should be rammed in a pit.

DRY SAND CHESTS FOR UPRIGHT STEAM ENGINES. Ram the pattern all in the knoll and turn it over on a mould board. The top flanges must be loose to come in the cope. Use an equal quantity of moulding and fire sand. Vent the mould well; before the large core is put in, dry the mould and core in the oven. One chaplet in the cope and knoll will be sufficient. The best place to gate is in the bottom flange. Steam chests can be made sound whether poured horizontally or perpendicularly; but the latter is preferable. Rapid pouring and sharp iron will be the best.

LARGE AND SMALL CANNON. Mould this pattern in halves, and in moulding and fire sand, an equal quantity. When dressed, black it with blacking made of charcoal and strong beer. Before the mould is closed,

let all the steam out of it. The best way to pour cannon, if you want to make them sound, is upright, and gate them in the bottom; this will force the sturge to the top of the riser. To prevent straining, it should be rammed in a pit. The iron need not be sharp nor poured very rapidly. It will be necessary to run fifty or sixty pounds of iron off the mould, after it is full, and to churn it until it is set. Cannon balls should be poured with dull iron.

DRY SAND CYLINDERS FOR HORIZONTAL ENGINES. This pattern should be moulded in halves, and turned over on a mould board. Use moulding and fire sand, an equal quantity. Each cope and knoll should be well vented. When the mould is dressed, black it with blacking mixed with strong beer. Smooth it with a halfround and other tools, so as to give the casting a smooth surface. While the mould is soft, vent the valve core prints through the knoll, and set the valve

cores before the mould is put in the oven. The centre core should be made in loam, and the steam permitted to escape from the mould before it is closed.

Cylinders should be run in the bottom flange, as the sturge will flow to the top and make the casting sound. Sharp iron is the best, and the pouring should be done rapidly. About fifty pounds of iron should be run off the casting to prevent it from cold shot on the top. It is best to prevent straining that it be rammed up in a pit, but if there be no pit, iron plates should be fastened to the cope and knoll.

DRY SAND BEETLING BEAMS FOR BLEACHERIES. Mould this pattern in halves, and turn it on a smooth board. Moulding and fire sand will be the best. The mould should be rammed hard and well vented, before the pattern in the cope is drawn out. It will need to be well spiked to prevent it from falling, while turning over. In dress-

ing the mould, use blacking mixed with strong beer. Beams should be run in the bottom, and the sturge forced to the top. About fifty pounds of iron should be run off the casting. The iron should be sharp and poured rapidly. It should be rammed up in a pit.

Note. The centre core should be made in loam. An equal quantity of common and fire sand will be the best for moulding sand for all kind of dry sand work.

DRY SAND.

OVAL AND FLAT SIDE RETORTS FOR GAS HOUSES. The pattern should be moulded in halves and turned over on a mould board. Use an equal quantity of moulding and fire sand. The mould should be rammed hard and well vented before the part in the cope is drawn out. It should be well spiked to prevent it from falling while turning over. Blacking mixed with strong beer is

the best to black the mould with. Smooth it with a half round while it is wet. Let the steam escape before the mould is closed. If the mould is to be poured horizontally, the side is the best place to gate it; set a riser on the flange. If it is to be poured perpendicularly, run it in the bottom with the flange up, and ram it up in a pit. The iron need not be poured sharp nor very rapidly. Loam will be the best in which to make the centre core.

Flat Side Retorts should be moulded and poured in the same manner as the oval.

COTTON MACHINERY.

FINE AND COARSE GEARING. The mould board should be of Plaster of Paris; if made correctly, it will part the spur and bevel patterns. The teeth should not be rammed hard, as fine patterns will not draw well. To prevent them from striking, rub bees-

wax with a hard brush. Dry the pattern well. Use fine sand and sift it through a fine sieve, which will give the casting a fine, smooth surface.

The best way to pour fine gearing is with horn runners ; if poured on the top, the teeth are apt to wash away. Sharp pointed bev-els can be poured teeth upwards ; they will run sharper, but the teeth are apt to fall if at all cracked. Fine gear should be poured rapidly with sharp iron to prevent it from cold shot. Both fine and coarse gearing will need risers to prevent it from straining.

COARSE GEARING of every description will need to be rammed harder than fine to prevent the teeth from swelling. Large patterns with arms will need to be poured with two ladles, and gated in the arms ; small ones with one ladle. Sharp iron will be best for coarse work ; it need be poured rapidly.

SIDES FOR SPINNING MULES. Turn the pattern over on a mould board. Care must be taken not to ram too hard over the top beathing, for fear that it may shell. Sides should be poured rapidly with sharp iron, gated at both ends and centre, to prevent it from straining. Risers will be necessary.

CARD SIDES FOR COTTON MACHINERY. Turn the pattern over on a mould board. The sides must be rammed hard, but not so the core. Short sides need not as many gates as long ones. Do not ram hard over the pattern ; if you do, it will blister and shell. Short and long sides must be poured at both ends and the centre ; sharp iron will be best, and also thin gates. Risers will be needed to prevent straining. Pour rapidly.

SIDES FOR WEAVING LOOMS. Turn the pattern over on a mould board. Do not ram hard over the top beathing. It will be necessary, in order to obtain a good lift, to

have the cope on hinges, and to lift it gently. It will be best to have sharp iron, and thin gates on the sides and ends. Risers will also be needed.

SPINNING FRAME ENDS. Turn the pattern over on a mould board. Do not ram the bottom part hard, except the sides; if rammed hard over the pattern, it will be apt to blister and shell. The gates should be thin in order to prevent it from straining. Pour with sharp iron and rapidly. The sides and ends are the best places in which to run all kinds of frame ends.

LARGE AND SMALL PULLEYS FOR MACHINERY. Mould the pattern in halves, and turn it on a mould board. The knoll will need to be rammed hard; if the rim part in the cope is rammed hard, it will blow and make the casting shell. Before the part in the cope is drawn, it will need to be spiked well to prevent it from falling while turning

over. Pulleys will need from two to four ladles, according to their size. There should be a riser on the top of the hub to prevent straining. In the arms is the best place to gate it.

PULLEY PATTERNS IN ONE PART FOR MACHINERY. The best way to mould deep pulleys is to use lifting plates that will fit between the arms; the handles should be as high as the top of the cope. It will be necessary to have slides on long pins to lift the cope steadily, and to ram the rim hard to prevent it from swelling. When the cope is rammed, wedge the handles with iron bars and wedges. Flat gates are best to run deep pulleys on the hub. Before the cope is closed, draw a vent wire over the rim; it will help to make it sound. Rapid pouring and sharp iron will run pulleys.

SHALLOW PULLEYS FOR COTTON MACHINERY. Have a mould board that will part

the arms. To obtain a good lift, it will be necessary to use lifters in the cope, and to rap the pattern before it is lifted off. Sharp iron is the best to run, and it should be poured rapidly, with a riser on the hub to prevent it from straining. To make pulleys in three part flasks, with loose arms, the rim should be drawn first, the cheeks should be lifted off before the centre core, and put on again before the cheeks. Patterns moulded in this way must be poured on the hub, with vents drawn over the rim.

PLATE PULLEYS FOR COTTON MACHINERY. Turn the pattern over on a mould board. The cope or knoll, except the sides, must not be rammed hard. If there is a deep lift on the pattern, it will be necessary to use lifters, and to rap it before the cope is lifted off. The best place to pour it is on the hub or plate; if poured on the sides, the gates will be apt to break into the casting. Flat gates are best to run plate pulleys; it

should be poured rapidly with sharp iron. Set a riser to prevent it from straining, and vent the cope and knoll well.

CASTINGS TO BE FINISHED IN A LATHE OR PLANER, of every description, should be cast face downwards; it will make the face sound, because the sturge is inclined to flow to the top. For that reason a sturge sprew should be had in every mould; if gated right, the sturge will flow into it. Sharp iron will make sounder castings than dull. Before the iron is taken from the furnace, the dirt should be skimmed off the ladle well; it will enable the moulder to skim clean while pouring.

STOVE PLATE WORK. Turn over this work on a mould board. Care must be taken not to ram the face of the casting too hard; the sides and ends should be rammed hard to prevent straining. Flour and charcoal are the best to give the casting a smooth

surface. First shake off the flour, and afterwards the charcoal. The sand will peel off better than if the flour and charcoal were mixed together in one bag. Stove plate should be poured rapidly, and with sharp iron. To prevent straining, risers should be placed on the top. When the cope is lifted off, shake charcoal and flour upon it; print it back on the pattern, and lift it off before it will sweat and stick. When the pattern is drawn, brush it dry with a hard brush; shake flour and charcoal on the knoll, and print it back. Stove plate should be poured with flat gates.

CYLINDER STOVES, for common use, of every description, should be moulded in three part flasks. Common sand is good enough to face them with. They should be poured rapidly, and with sharp iron. To prevent straining, there should be a riser and thin gates to the castings.

AGRICULTURAL AND PLOUGH WORK. Turn this work over on a mould board. Neither the cope or knoll should be rammed hard over the face. The best place to gate moulds with square edges is in the side, but moulds with feather edges must be run on the top. The most expeditious method of moulding chill work is to ram up the chill to whatever part of the casting is to be chilled; this will save the labor of cutting out the sand for the chill, after the knoll is turned over. Sharp iron and rapid pouring will be best. Cultivators, and all kinds of cast iron work for ploughs, should be made of very hard iron, to prevent them from wearing too fast. The face of chills should be oiled, to prevent them from blowing or blistering; it will be necessary to run some iron off the casting. Sleigh shoes should be chilled, but if that is impossible, mould them in strong facing sand; after pouring, take them out when red, and dip them in cold water. This operation will make them

as hard as if chilled, and they will wear as long.

LOOM WORK BUILT IN BRICK.

GENERAL INSTRUCTIONS. Lay the brick on the length. Use mortar made of moulding sand and water. Two layers of brick in thickness will be strong enough. It will be necessary to lap strong hoop iron around the outside, made tight with wire, and a pliers to strengthen it. Soft brick are best to build the core and cope with; two layers will be thick enough for the core, and they should be laid in the same manner as in the cope. All kinds of loom work that has a bottom, require the core to be hollow inside in order to vent the mould while pouring. The safest way to make loom castings of equal thickness is to have wrought iron stead pins in the ring the core is built on, and pin holes the cope is built on. This will prevent the cope from rubbing hard on

the bearing while closing it. The core and cope should be put in the oven together, if possible; if not, dry the core where it is by putting fire under it. The centre and bottom plate must be levelled with a spirit level before the core is built.

INDIGO POTS WITHOUT PATTERNS. First strike up the core and bearing; then dry it well and black it with blacking made of strong beer and charcoal. Strike it with a trowel when the blacking is dry. Shift the strickle to the thickness you intend to make the casting, and make up the core again with loam and strickle; then dry, and black it when dry. Build up the cope and place loam next to the core. When built, put all in the oven, and let them dry well before they are taken out. It will be necessary, before the cope is lifted off, to have a cross inside the churns to prevent them from rubbing too hard on the brick work. When the thickness of loam is taken off, the core

and cope must be washed before the blacking is put on again. Indigo pots that are narrower at the neck than at the bottom, must be made with the cope ring in two halves, with the cope built on the core, as if the ring was entire. A parting must be made in the brick opposite the joint of the two half rings, with paper, and the cope dried on the core. When the cope is well dried, lift it off sideways and mark the rings before they are lifted off. This will be a guide for the moulder to go by when putting on the cheeks. Before the mould is put in the pit, level the bottom of it and clamp the cope and core together. This will prevent it from straining the bottom flange. Before the moulder commences to ram the pit, he must set an air pipe that will convey the air and gas from the bottom of the mould to the top. Care must be taken that no hot iron or red shavings touch the vent while the mould is pouring, for such an accident will drive the gas back to

the mould, and perhaps cause an explosion and endanger life. To guard against accidents of any kind, I would recommend that the air and gas be conveyed outside through an air tight pipe or funnel, and covered with sand. Pots should not be poured with sharp iron, nor very rapidly. Two round gates will be sufficient for any sized indigo pot. A riser should be placed on the centre; the bottom of the gates and the riser should be a bell mouth. This will prevent them from breaking into the casting.

INDIGO BOILERS WITH FLAT BOTTOMS require the same treatment as indigo pots, with a little more labor. If there is a cock to be cast on the side near the bottom, build it in the cope, and leave the pattern in until it is dried. The top cope should be made as soon as the brick is set in the cope, and all dried in the oven together. It will be necessary to clamp the bottom ring and cope to prevent the iron

from running out while pouring. Sharp iron and rapid pouring are the best.

STEAM CYLINDERS FOR UPRIGHT ENGINES.

This casting will require a wooden pattern in several pieces. Build it in the cope and dry it in the oven. Before any part of the pattern is drawn out, lift off the cope and draw one piece at a time. If there is no pattern, use a strickle. The most skilful way is to have wooden flanges, cut in segments, built in the cope. If the strickle is made to strike up the flanges, it will answer as a substitute for a whole pattern, and dispense with wooden ones. The cope must be built before the core, and dried in the oven. The centre of the core must be hollow to permit the air to escape. When the mould is in the pit, ram the centre of the core with sand; this will prevent the inside from straining. Vent it well with a thick vent wire. The top cope should be a ring with loam on it, and

wide enough to cover the top of the mould. Before the pit is rammed, clamp it from the bottom. Sharp iron and rapid pouring are best.

CONDENSERS FOR UPRIGHT STEAM ENGINES should be made in the same way as the Indigo Boiler, except the branch part, and should be built in the cope. It will be necessary to pour the branch with a shank ladle, rapidly, and with sharp iron.

DISTILLERY BOILERS should be made in the same way that indigo pots are made, but poured more rapidly, with sharper iron.

SUGAR ROLLS. First build the cope and dry it in the oven. The core should be hollow in the centre. It should be poured rapidly, with not very sharp iron. It will be necessary to run about fifty pounds of iron off the casting.

CURVES. The best way to make this casting is to have a wooden pattern in segments; build it in the cope. First, make the core; the centre should be hollow. When the mould is in the pit, ram the centre and outside at the same time; this will prevent it from straining. The top cope should be a ring, with loam on the bottom and top, clamped. The iron should be sharp and the pouring rapid.

LOOM WORK. All kind of loom castings should be taken out of the pit, as soon as possible, after pouring. Dig out the brick in the core to prevent the casting from cracking while shrinking.

RAILROAD CHAIRS. Turn over the pattern on a mould board. The knoll should be rammed hard to prevent straining. Facing sand will be the best to prevent scabbing. When the cores are set, stop them over with

iron chills. The iron should not be very sharp nor poured rapidly.

MALLEABLE IRON WORK. You should have a mould board made of plaster of Paris. The cope and knoll should be made to come apart after the mould is finished; this will save the labor of making wooden flasks. The moulds should be weighed down with flat iron, and poured with sharp iron, but not too rapidly.

SHRINKAGE, OR CONTRACTION OF CASTINGS.

The contraction will be one eighth of an inch to every foot the pattern measures. Hard and soft iron, in light and heavy work, will shrink the same. Patterns should be made to allow for the shrinkage. Care must be taken not to have the sprews too near the cross pieces. It will be necessary to dig around them, after casting, in order to prevent the cross pieces from breaking, while the casting is shrinking.

A METHOD

Of ascertaining the weight of Castings without cores, before the Mould is poured.

First, weigh the pattern; then multiply the weight of the pattern by 15. This rule is applicable only to hard wood patterns.

EXAMPLE. If a pattern, 2 feet in diameter and 3 inches thick, weigh 19 lbs., what will the casting weigh? Ans., 285 lbs.

The most correct method of ascertaining the weight of a casting with cores, is to weigh the patterns and also the cores. Cast iron is about two and a half or three times as heavy as cores, without rods. For instance: weigh a round core, and get a piece of round iron of the same length and diameter, and weigh them separately.

The weight of columns and pipe must be taken by estimation on account of the arbors; all other kinds of patterns may be weighed.

EXAMPLE. If a hard wood pattern, 17 feet long, 10 inches deep and 18 inches wide, weigh 635 lbs., what will a casting 15 times as heavy weigh? Ans., 95 cwt., 25 lbs.

If the above described pattern has dry sand cores, subtract three times the weight of the cores from the weight of the casting.

EXAMPLE. If a set of cores weigh 225 lbs., what will a set three times as heavy weigh? Ans., 8850.

ERRATA. In the absence of the author, some errors have occurred in printing. Page 15, 4th line, for "fit" read *file*; 6th line, for "cores" read *iron*. Page 23, for "hule" read *hub*. Page 38, 7th line, for "ram" read *run*.

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